XIV. THE GENERA AND SPECIES OF THE TRACHODONTIDÆ (HADROSAURIDÆ, CLAOSAURIDÆ) MARSH.

By J. B. Hatcher.

In March 1856[1] Dr. Joseph Leidy described under the name of *Trachodon mirabilis* certain teeth pertaining to a herbivorus reptile allied to Iguanodon. These teeth were discovered by Dr. F. V. Hayden in deposits, now generally considered as Laramie, in the "Bad Lands" of the Judith river, in Montana. No figures accompanied Leidy's original description. Three years latter however Dr. Leidy gives a more detailed description of this new genus and species accompanied by excellent figures of the teeth upon which it was founded.[2] Unfortunately Dr. Leidy failed to designate any particular tooth as the type of the genus and species and his figures show that he has included teeth belonging to two quite distinct forms of dinosaurs. Figs. 1–17 represent teeth with simple roots closely resembling the teeth of certain Iguanodont dinosaurs, which by Leidy, Cope, Marsh, and others have since been variously referred to under the names of *Trachodon*, *Thespesius*, *Hadrosaurus*, *Diclonius*, *Claosaurus*, etc. Figs. 18 to 20 represent different views of a tooth with two roots and of quite a different pattern. This tooth, as we know by later discoveries, belonged to a very different dinosaur pertaining to a family, representatives of which have since been described by Cope and Marsh under various generic names as *Dysganus*, *Agathaumas*, *Monoclonius*, *Ceratops*, *Triceratops*, *Torosaurus*, etc.

While Leidy has nowhere designated any of the teeth described and figured in the above mentioned publications as the type of *Trachodon mirabilis*, yet on page 141 of the paper last cited he says: "Of the specimens of teeth referred to Trachodon, the unworn crown is the most important. It is represented in plate 9, figs. 1–3." This may then be very properly considered as the type of the genus and species, while the quite different two-rooted tooth above referred to would pertain to a distinct genus. Moreover this would seem to be the view taken by the late Professor Marsh when in 1890 he described as *Trachodon longiceps* the lower jaw of an Iguanodont dinosaur with very similar, if not identical, simple-rooted teeth.[3] The type of *T. longiceps* was obtained by the present writer in about the same horizon, though in a different locality, as were the teeth described by Dr. Leidy.

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[1] See Proc. Phil. Acad. Sci., 1856, p. 72.

[2] See Trans. Am. Phil. Soc., 2d Ser., Vol. II., pp. 140–143, Pl. 9, figs. 1–16.

In December, 1856, under the name of *Thespesius occidentalis* Dr. Leidy described two caudal vertebræ and a first phalanx of a large dinosaur.[4] These remains were found in the lowest member of the Lignite formation, essentially the same horizon as those from which the teeth were procured.

Two years later or in December, 1858,[5] Dr. Leidy described a third new genus and species of Iguanodont dinosaur under the name of *Hadrosaurus foulkii.* The remains upon which this genus and species were founded were taken from the Cretaceous marls near Haddonfield, New Jersey, and consisted of twenty-eight vertebræ with their processes mostly wanting; a complete humerus, radius and ulna; an imperfect ilium and pubis; a femur, tibia and fibula; two metatarsal bones and a first phalanx, nine teeth and a fragment of the lower jaw. These remains were later more fully described and adequately illustrated by Dr. Leidy.[6] In this paper Dr. Leidy fully realized the very close relationship and probable identity of the genera *Trachodon*, *Thespesius* and *Hadrosaurus* which he had proposed for the reception of these remains from three widely separated localities. On page 84 he says "several of the teeth of *Hadrosaurus* are nearly identical in form and details of structure with the specimen of a tooth discovered a short time previously to the former, by Dr. F. V. Hayden, in the Bad Lands of the Judith River. The tooth just mentioned, together with several other much worn specimens, I referred to a distinct genus under the name of *Trachodon*, but I shall not be surprised to learn that future discovery determined *Hadrosaurus* and *Trachodon* to be the same." While in a footnote on the same page in speaking of *Thespesius* he says, "had the remains of *Thespesius* and *Trachodon* been found in a deposit of the same age I should have unhesitatingly

[3] See Am. Jour Sci., 1890, Vol. XXXIX., p. 422.

[4] See Proc. Acad. Nat. Sci. of Phil., 1856, p. 311, 312.

[5] See Proc. Acad. Nat. Sci. of Phil., 1858, pp. 215–218.

[6] See Cretaceous Reptiles of the United States. Smith. Contr. to Knowledge, 1865, Vol. XIV., pp. 76–97, Plates XII.–XVII.

referred them to the same animal, and I cannot avoid the suspicion that future investigation may determine them to be the same. Should such a determination prove to be the case, the minor details of structure of the tooth of *Trachodon* different from those of *Hadrosaurus*, together with the convexo-concave anterior caudals and the plano-concave posterior caudal of *Thespesius*, in comparison with the biconcave caudals of *Hadrosaurus*, will be sufficient to separate generically the New Jersey Dinosaurian from that of the Upper Missouri." I have already remarked that we are now quite certain that the types of *Trachodon* and *Thespesius* came from essentially the same horizon, but in regard to the relative horizons of the western and New Jersey beds we cannot be so sure. It would seem however that the New Jersey Dinosaur came from a somewhat lower horizon than did the others, and this supposition in connection with the anatomical differences pointed out by Leidy, together with their wide geographical distribution, might be taken to indicate that the remains of *Hadrosaurus* pertained to an animal generically distinct from *Trachodon*. This however can only be determined by a comparison of the remains of *Hadrosaurus* with the more recently discovered skeletons of *Trachodon* which have since been found in the same deposits in the west as were the type specimens, though unfortunately they have been referred to various genera such as *Cionodon*, *Diclonius*, *Claosaurus*, etc.

Three years after publishing his "Cretaceous Reptiles of the United States" Dr. Leidy became fully convinced of the generic identity of *Trachodon* and *Hadrosaurus*. In a communication to the Philadelphia Academy of Sciences in 1868,[7] he says, "*Hadrosaurus Foulkii*, the bulky vegetable feeder, and contemporary of the rapacious *Lælaps aquilunguis*, was at most probably only specifically distinct from *Trachodon mirabilis*, the teeth of which were found in association with those of *Dinodon*, so that, according to the laws of nomenclature, as *Trachodon* has priority of name, I suppose the first mentioned animal must be called *Trachodon Foulkii*, though the names of *Hadrosaurus Foulkii* and *H. mirabilis* would appear more appropriate for these powerful dinosaurs.

"The best preserved tooth of those originally referred to *Trachodon*, represented in Figs. 1–6 of the plate above cited, is identical in form with those referred to *Hadrosaurus*, and differs only in the absence of the rugulations of the lateral borders of the crown, and in some less important points.

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[7] See Proc. Phil. Acad. Sci., 1868, p. 199.

"The remaining specimens of teeth referred with the former to *Trachodon*, are represented in Figs. 7–20 of the plate cited. Most of them are so worn and probably altered from their original form, that it is rendered uncertain whether they belong to the same animal as the preceding tooth, and one unworn (Figs. 18–20) has a very different shape from this. Perhaps these specimens belonged to another Dinosaur, for which the name *Trachodon* might be reserved, while that of *Hadrosaurus* might include the first mentioned and more characteristic tooth.

"As *Iguanodon* had its enemy in a species of *Megalosaurus*, *Trachodon*, the representative of the former both in the western and eastern portions of the North American continent was accompanied by an equally bloodthirsty enemy, which may, perhaps, on nearer comparison of corresponding parts, prove to be another species of the same genus, until now supposed to be different, under the names of Dinodon and Lælaps."

From the above quotation it will be seen that Leidy now recognized the distinct nature of the tooth shown in Figs. 18–20 of the plate cited and at the same time considered *Hadrosaurus* a synonym of *Trachodon*. I fail however to see how he can be interpreted as having abandoned the genus *Trachodon*, as Cope later seems to have construed his words.[5]

If Leidy was correct in considering *Trachodon* and *Hadrosaurus* as synonyms, the presence of remains of so highly a specialized genus of the dinosauria in the fresh water Laramie deposits of the West and in the marine upper green sands of the New Jersey Cretaceous would seem to be of considerable importance in reaching a conclusion as to the proper correlation of the Cretaceous deposits of these widely seperated regions.

Two new species, *Trachodon* (*Hadrosaurus*) *minor* and *T.* (*Hadrosaurus*) *tripos*, were proposed respectively by Marsh and Cope in 1870, and described in the Proceedings and Transactions of the American Philosophical Society. In 1871 Cope adds another species, *T.* (*Hadrosaurus*) *cavatus*, describing it in the Proceedings of the American Philosophical Society for 1871. The first of these three species was founded on fragmentary lumbar and caudal vertebræ, the last two on poorly preserved caudal vertebræ.

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[5] See footnote, p. 99, Proc. Phil. Acad. Sci., 1883 and 1876, p. 253. In a later communication (Proc. Phil. Acad. Sci., 1870, p. 68) than that cited by Cope Leidy places *Trachodon mirabilis* as a synonym of *Hadrosaurus mirabilis*, apparently overlooking the fact that Trachodon has priority.

In 1870 Cope proposed the genus and species *Hypsibema crassicauda* for the reception of some caudal vertebræ and fragmentary limb- and foot-bones belonging to one of these dinosaurs which he described in the Transactions of the American Philosophical Society for 1870, and in the Proceedings of the same Society for 1871.

The next genus and species proposed for these dinosaurs was *Cionodon arctatus*[9] Cope, first described in 1874, and founded on a portion of a right maxillary with several teeth in position found in Colorado, no more definite locality being given. In the succeeding year (1875)[10] Professor Cope gave a further description of this genus, adding a new species *C. Stenopsis*, founded on material collected by the late Dr. G. M. Dawson said to be from the Ft. Union beds of the Milk River region, Canada. At that time, as now, the Ft. Union and Laramie deposits were not easily distinguishable, and it is quite probable that this material was from a horizon approximately the same as that of the other material from the West upon which the foregoing genera and species have been proposed.

In the same year Professor Cope proposed still another new genus, *Polygonax*, for these dinosaurs. He described the species as *P. mortuarius*, founded on three dorsal vertebræ and some fragments of limb bones found in Colorado[11] in association with the remains referred to *Cionodon arctatus*.

In 1876[12] the genus *Diclonius* was proposed by Cope for the reception of certain remains of these predentate dinosaurs and three new species, *D. pentagonus*, *D. perangulatis*, and *D. calamarius*, were introduced, based on shed teeth found associated according to that author with those of *Trachodon mirabilis* in the Laramie (Ft. Union) deposits.

On page 99 of the Proc. of the Phil. Acad. of Sci. for 1883, in his "Characters of the Skull in the Hadrosauridæ" Cope, says, "The species on which these observations are based is the *Diclonius mirabilis* of Leidy," and in a footnote he adds, "This species is part of one called by Leidy *Trachodon mirabilis*, who included in it a species of *Dysganus*. He did not characterize the genus *Trachodon*, and afterwards abandoned it. (Proceedings Academy, Phila., 1868, p. 199.)"[13] We have already shown that Leidy had not abandoned the genus and had fully characterized it, accompanying his descriptions with splendid illustrations of the material at his command. There would seem therefore little doubt as to the synonymy of *Diclonius* and *Trachodon*. The splendid skeleton of *Trachodon* (*Diclonius*) *mirabilis* discovered by Drs. Wortman and Hill in the Laramie of South Dakota enabled Professor Cope to more fully characterize that genus than it had been possible for Dr. Leidy to do. A careful comparison between this skeleton and the remains from Haddonfield, New Jersey, of *Hadrosaurus foulkii* should determine whether or not the latter genus is a synonym of *Trachodon*.

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[9] Bull. U. S. G. S. of the Terrs., No. 1, 1875, p. 2.

[10] Vert. of Cre. form. of the West, Rep. U. S. G. S. of the Terrs., Vol. II., 1875, pp. 57–63.

[11] See Rep. on the Vert. Pal. of Col., An. Rep. U. S. G. S. Terrs. for 1873, pub. 1875, pp. 451–452.

[12] See Proc. Phil. Acad. Sci., 1876, pp. 253–255.

Claorhynchus trihedrus[14] was applied by Cope to a rostral and predentary bone (locality and horizon not given) which he considered as pertaining to the *Agathaumidae* but which would appear from the description given to more properly belong to the *Trachodontidae*.

In 1889[15] Professor Cope proposed still another genus and species, *Pteropelyx grallipes* for these dinosaurs, based upon a portion of a skeleton discovered by Mr. J. C. Isaac near Cow Island, Montana, on the Upper Missouri River some forty miles below the mouth of the Judith River. The locality and horizon are essentially the same as those from which Dr. Hayden procured the types of *Trachodon* and there can be no doubt as to the identity of the two genera. In 1892[16] Cope considered *Pteropelyx* and *Claosaurus* as synonyms. In the paper last cited he says (p. 758): "*Pteropelyx Cope*—This genus was described by me in The American Naturalist for October, 1889, p. 904 (published March 5, 1890). It has been subsequently named by Marsh, *Claosaurus*, in the American Journ. Sci. Arts, for May, 1890 (p. 243)." The discovery of more complete material of *Pteropelyx* has shown the identity of that genus and *Trachodon*.

In 1889 Professor Marsh proposed two new species—*Trachodon* (*Hadrosaurus*) *breviceps* and *T.* (*Hadrosaurus*) *paucidens*, founded on fragments of jaws from the Bad Lands on the Judith River, in Montana, the same locality as that which yielded the type of the genus.[17]

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[13] See Proc. Phil. Acad. Sci. 1883, pp. 93–107, Plates IV.–VII.

[14] See Am. Nat., 1892, p. 757.

[15] Ibid., 1889, p. 904.

[16] Ibid., 1892, p. 758.

[17] See Am. Jour. Sci., Vol. XXXVII., April, 1888, pp. 335, 336.

In 1890[18] Marsh described a third species *Trachodon longiceps*, already referred to, from the Laramie of Converse County, Wyoming. In the same communication he removed a fourth species which had been described by him in April, 1872,[19] as *Hadrosaurus agilis* from that genus, creating for it a new genus *Claosaurus*. The type of *Claosaurus agilis* according to Marsh came from the Pteranodon horizon of the Niobrara formation, near the Smoky Hill River in western Kansas, and consisted of a considerable portion of the skeleton. From Marsh's description of the parts found and considering the geological horizon in which the remains were discovered there would seem to be little doubt that *Claosaurus agilis* is generically and specifically distinct from any of the preceding genera and should therefore be retained.

In May, 1892, Professor Marsh[20] describes a fifth species of these dinosaurs—*Claosaurus annectens*, founded upon a nearly complete skeleton from the Laramie of Converse Co., Wyoming. It is somewhat remarkable that Professor Marsh should have referred this specimen to this genus considering that the type of *Claosaurus* came from the Pteranodon beds of the Colorado series. It would seem improbable that so highly specialized a genus should have continued uninterruptedly throughout so long a period as that which extended from the Niobrara to the upper Laramie. Whether or not *Claosaurus agilis* and *C. annectens* are generically distinct can alone be determined by a careful comparison of the type specimens. Of the generic identity of *Trachodon mirabilis* of Leidy and Cope and *Claosaurus annectens* there can be no doubt and there is little question but that they are specifically identical. The almost complete skeletons which were described by Cope and Marsh respectively as *Diclonius mirabilis* and *Claosaurus annectens* were found in the same geological horizon and in essentially the same locality, the former northeast of the Black Hills and the latter southwest of the same mountains. Such minor differences as do exist in the two skeletons are due either to distortion as a result of pressure, to individual variation, or at most the little structural differences that are discernible are certainly of not more than specific importance. We have already shown that *Diclonius* is a synonym of *Trachodon*, and *Claosaurus annectens* should therefore be known as *Trachodon annectens*, restricting for the present the genus *Claosaurus* to the form from the Pteranodon beds, which latter however if eventually shown to be generically identical with *T.* (*Claosaurus*) *annectens*, as Marsh supposed, will then have to be referred to *Trachodon*, resulting in the abandonment of the genus *Claosaurus* as a synonym of *Trachodon*.

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[18] See Am. Jour. Sci., Vol. XXXIX., 1890, pp. 422–424.

[19] See Am. Jour. Sci., Vol. III., p. 301, April, 1872.

[20] See Am. Jour. Sci., Vol. XLIII., May, 1892, p. 453.

Trachodon (*Claosaurus*) *annectens* is further noticed by Professor Marsh in August, 1892,[21] and in October of the same year.[22] In the latter communication he gives a restoration of the skeleton based upon the excellent material at his command. In January, 1893, he gives a description of the skull and brain.[23] In 1890,[24] Professor Marsh proposed for these dinosaurs the family name *Trachodontidæ* to replace the *Hadrosauridæ* proposed by Cope in 1869,[25] to which family these dinosaurs had already been referred. Later he includes in the *Trachodontidæ* only such genera and species as had been proposed by Leidy and Cope, placing the genus *Claosaurus* in a new family, the Claosauridæ[26] on very insufficient grounds. There can be no question concerning the synonymy of the family name *Claosauridæ* with that of *Trachodontidæ*, which is to be preferred to that of *Hadrosauridæ* since the genus from which the latter was derived becomes a synonym of *Trachodon*. It is doubtful, however, whether the family name *Trachodontidæ* should not be abandoned in favor of *Iguanodontidæ*, which has priority and was proposed for the reception of the European forms. Iguanodontidæ would then include both the American and European forms of these closely related dinosaurs.

Following is a list of the various genera and species of Trachodontidæ that have been proposed, with author's name and a reference to the original description of each.

Trachodon mirabilis Leidy, Proc. Phil. Acad. Sci., March, 1856, p. 72.

Thespesius occidentalis Leidy, Proc. Phil. Acad. Sci., December, 1856, p. 311.

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[21] See Am. Jour. Sci., Vol. XLIV., August, 1892, pp. 171–173, Plates II. and III.

[22] Ibid., Vol. XLIV, October, 1892, pp. 343–346, Plate VI.

[23] Am. Jour Sci., Vol. XLV., Jan., 1893, pp. 83–86, Plates IV.–V.

[24] Ibid., Vol. XXXIX., 1890, p. 424.

[25] See Proc. Phil. Acad. Sci., 1883, p. 99.

[26] See Am. Jour. Sci., December, 1895, p. 498, and Dinosaurs of North America 16th Ann. Rep. U. S. G. S., p. 244.

Hadrosaurus foulkii Leidy, Proc. Phil. Acad. Sci., December, 1858, pp. 215–218

Hadrosaurus minor Marsh, Proc. Phil. Acad. Sci., January, 1870, p. 2.

Hadrosaurus tripos Cope, Trans. Am. Phil. Soc., 1870, p. 122.

Ornithotarsus immanis Cope, Proc. Am. Phil. Soc., 1889, p. 117.

Hadrosaurus cavatus Cope, Trans. Am. Phil. Soc., 1871.

Hadrosaurus agilis Marsh, Am. Jour. Sci. and Arts, April, 1872.

Cionodon arctatus Cope, Bull. U. S. G. S. Terrs., No. 1, 1874, p. 2.

Cionodon stenopsis Cope, Vertebrata of the Cretaceous Formations of the West; An. Rep. U. S. G. S. Terrs., Vol. II., 1875, pp. 57–63.

Polygonax mortuarius Cope, An. Rep. U. S. G. S. Terrs. for 1873, pub. 1875, pp. 451–452.

Diclonius pentagonus Cope, Proc. Phil. Acad. Sci., 1876, pp. 253–255.

Diclonius perangulatus Cope, Proc. Phil. Acad. Sci., 1876, pp. 253–255.

Diclonius calamarius Cope, Proc. Phil. Acad. Sci., 1876, pp. 253–255.

Hadrosaurus breviceps Marsh, Am. Jour. Sci., April, 1889, p. 335.

Hadrosaurus paucidens Marsh, Am. Jour. Sci., April, 1889, p. 336.

Pteropelyx grallipes Cope, Am. Nat., October, 1889, p. 904–905.

Trachodon longiceps Marsh, Am. Jour. Sci., May, 1890, p. 422.

Claosaurus (*Hadrosaurus*) *agilis* Marsh, Am. Jour. Sci., May, 1890, p. 423.

Claosaurus annectens Marsh, Am. Jour. Sci., May, 1892, p. 453.

Claorhynchus trihedrus Cope, Am. Nat., Sept. 1892, p. 757.

A careful examination of the original descriptions and figures of the types of the ten genera and twenty species enumerated above, shows that there should be a great reduction in each and that the ten genera which have been proposed should be reduced to two *Trachodon* Leidy and *Claosaurus* Marsh, while the remaining eight genera should be treated as synonyms of Trachodon, which should also be made to include *T.* (*Claosaurus*) *annectens* Marsh; while the smaller *Claosaurus agilis* described by Marsh from the Kansas chalks may still be considered as pertaining to a distinct genus.

Doubtless many of the species are also synonyms but this can only be determined by a careful comparison of the types.

THE DERMAL COVERING OF TRACHODON.

The writer has recently described and figured certain impressions of the dermal covering of Trachodon preserved in a block of sandstone containing a portion of the pelvic and caudal regions of a skeleton of one of these dinosaurs found in the Laramie deposits of Converse Co., Wyoming.[27] At the same time the claim was made that this was the first published description concerning the dermal covering of dinosaurs. I have since discovered that Professor Cope had already in Dec, 1885[28] published a description with figures of dermal impressions from the same region of the body as those described by the writer and pertaining to the same species *Trachodon* (*Diclonius*) *mirabilis* Leidy.

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Sept. 28, 1901.

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[27] See Science, N. S., Vol. XII., Nov. 9, 1900, pp. 719–720.

[28] See Am. Naturalist, Vol. XIX., p. 1208, XXXVII.